

Application No. 10/607,905  
Amendment Submitted with RCE  
January 15, 2009

**Amendments to the Claims:**

This listing of claims will replace all prior versions, and listings, of claims in the application.

**Listing of Claims:**

Claims 1-24 (cancelled).

Claim 25 (new).        An in situ cleaning process for removal of residue build-up from a deposition chamber of a plasma-enhanced chemical vapor deposition tool having multiple showerheads at respective multiple wafer stations, the process comprising, in any order:

         passing a perfluorocarbon gas  $C_xF_y$  with  $y > 6$  through the showerheads into the chamber for a first duration at first flow rate, chamber pressure and RF power settings;

         passing the gas through the showerheads into the chamber for a second duration at second flow rate, chamber pressure and RF power settings; the second duration being shorter than the first duration; and the second chamber pressure and RF power settings being greater than the first chamber pressure and RF power settings; and

         passing the gas through the showerheads into the chamber for a third duration at third flow rate, chamber pressure and RF power settings; the third flow rate and chamber pressure settings being substantially less than, and the third RF power setting being less than, the first flow rate, chamber pressure and RF power settings;

         the gas passed at the second flow rate, chamber pressure and RF power settings serving to remove residue build-up from sides of the showerheads not removed by the gas passed at the first flow rate, chamber pressure and RF settings.

Claim 26 (new).        The in situ cleaning process of Claim 25, wherein the perfluorocarbon gas is selected from the group consisting of: octafluoropropane ( $C_3F_8$ ), cyclic-octafluorobutane ( $c-C_4F_8$ ), and octafluorotetrahydrofuran ( $C_4F_8O$ ).

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Claim 27 (new).        The in situ cleaning process of Claim 26, wherein the third flow rate setting is about 60% of the first flow rate setting; and the third chamber pressure setting is less than 30% of the first chamber pressure setting.

Claim 28 (new).        The in situ cleaning process of Claim 27, wherein the second duration is about 25% of the first duration.

Claim 29 (new).        The in situ cleaning process of Claim 28, wherein the second flow rate setting is substantially equal to the first flow rate setting.

Claim 30 (new).        The in situ cleaning process of Claim 25, wherein the third flow rate setting is about 60% of the first flow rate setting; and the third chamber pressure setting is less than 30% of the first chamber pressure setting.

Claim 31 (new).        The in situ cleaning process of Claim 25, wherein the second duration is about 25% of the first duration.

Claim 32 (new).        The in situ cleaning process of Claim 31, where the third duration is a function of the first duration.

Claim 33 (new).        The in situ cleaning process of Claim 32, where the third duration is a fixed time plus a fraction of the first duration.

Claim 34 (new).        The in situ cleaning process of Claim 25, wherein the second flow rate setting is substantially equal to the first flow rate setting.

Claim 35 (new).        The in situ cleaning process of Claim 25, wherein an end of the first duration is determined by a change in concentration of cleaning by-products.

Claim 36 (new). The in situ cleaning process of Claim 25, wherein the end of the first duration is determined by a measured increase in fluorine or decrease in carbon monoxide produced by reactions between the gas and the residue in the chamber.

Claim 37 (new). The in situ cleaning process of Claim 36, wherein changes in fluorine or carbon monoxide determined by measuring optical emission signals at 704 and 483 nanometers, respectively.

Claim 38 (new). The in situ cleaning process of Claim 25, wherein the first and second pressure settings are between about 3.0 and 4.0 Torr; the third pressure setting is between about 0.5 and 0.8 Torr; the first and second flow rate settings are substantially the same between about 600 and 1200 sccm; and the third flow rate setting is about 500 sccm.

Claim 39 (new). The in situ cleaning process of Claim 38, wherein the first, second and third RF power settings are between about 2000 and 4000 Watts.

Claim 40 (new). The in situ cleaning process of Claim 38, further comprising passing oxygen together with the perfluorocarbon gas into the deposition chamber during the cleaning steps.

Claim 41 (new). The in situ cleaning process of Claim 40, wherein oxygen is passed at flow rate settings wherein the ratio of flow rate of oxygen to flow rate of fluorocarbon gas is between about 2:1 and 4:1.

Claim 42 (new). The in situ cleaning process of Claim 41, wherein oxygen is passed at a flow rate setting between about 1900 and about 3000 sccm for the first and second

durations, and at a flow rate setting between about 1000 to 2000 sccm during the third duration.

Claim 43 (new). The in situ cleaning process of Claim 25, further comprising moving from one cleaning step to another in response to monitoring cleaning by-products of residue removed from the chamber.

Claim 44 (new). The in situ cleaning process of Claim 43, wherein moving from one cleaning step to another is done in response to measuring fluorine and carbon monoxide by-products using an optical spectrometer configured to measure optical emission signals at 704 and 483 nanometers, respectively.

Claim 45 (new). The in situ cleaning process of Claim 25, wherein transitions from one cleaning step to another are determined by a controller in response to reading at least some of the first, second and third durations and first, second and third flow rate, chamber pressure, RF power settings from a data file.

Claim 46 (new). In an in situ cleaning process for removal of residue build-up from a deposition chamber of a plasma-enhanced chemical vapor deposition tool having multiple showerheads at respective multiple wafer stations, comprising:

- passing a fluorocarbon gas through the showerheads into the chamber for a first duration at first flow rate, chamber pressure and RF power settings; and

- passing the gas through the showerheads into the chamber for a second duration at second flow rate, chamber pressure and RF power settings; the second flow rate and chamber pressure settings being substantially less than, and the second RF power setting being less than, the first flow rate, chamber pressure and RF power settings;

- the gas passed at the first flow rate, chamber pressure and RF settings serving to remove residue build-up from sides of the showerheads; and the gas passed at the second

flow rate, chamber pressure and RF settings serving to remove residue build-up from the rest of the chamber;

the improvement comprising:

passing the gas through the showerheads into the chamber for a third duration at third flow rate, chamber pressure and RF power settings; the third duration being shorter than the first duration; and the third chamber pressure and RF power settings being greater than the first chamber pressure and RF power settings;

the first, second and third durations occurring in any order; and the gas passed at the third flow rate, chamber pressure and RF settings serving to remove residue build-up from sides of the showerheads not removed by the gas passed at the first flow rate, chamber pressure and RF settings.

Claim 47 (new). The improvement of Claim 46, further comprising the gas being a perfluorocarbon gas  $C_xF_y$  with  $x > 2$  and  $y > 6$ .

Claim 48 (new). The improvement of Claim 47, wherein the gas is selected from the group consisting of: octafluoropropane ( $C_3F_8$ ), cyclic-octafluorobutane ( $c-C_4F_8$ ), and octafluorotetrahydrofuran ( $C_4F_8O$ ).

Claim 49 (new). The improvement of Claim 47, wherein the third duration is about 25% of the first duration.

Claim 50 (new). The improvement of Claim 47, wherein the third flow rate setting is substantially equal to the first flow rate setting.

Claim 51 (new). The improvement of Claim 47, wherein the first and third pressure settings are between about 3.0 and 4.0 Torr; the second pressure setting is between about

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0.5 and 0.8 Torr; the first and third flow rate settings are substantially the same between about 600 and 1200 sccm; and the second flow rate setting is about 500 sccm.

Claim 52 (new). The improvement of Claim 51, wherein the first, second and third RF power settings are between about 2000 and 4000 Watts.

Claim 53 (new). The improvement of Claim 51, wherein oxygen is passed together with the perfluorocarbon gas, with a ratio of flow rate of oxygen to flow rate of fluorocarbon gas for each of the first, second and third flow rate settings being between about 2:1 and 4:1.

Claim 54 (new). The improvement of Claim 53, wherein oxygen is passed at a flow rate setting between about 1900 and about 3000 sccm for the first and third durations, and at a flow rate setting between about 1000 to 2000 sccm during the second duration.

Claim 55 (new). A method of manufacturing semiconductor devices, comprising:  
transferring wafers to respective multiple wafer stations in a deposition chamber of a plasma-enhanced chemical vapor deposition tool;  
depositing layers of material onto the wafers via showerheads respectively located at the wafer stations;  
removing the wafers with the deposited layers from the chamber;  
repeating the transferring, depositing and removing steps until deposition residue build-up in the chamber reaches a given thickness; and then  
cleaning the chamber using an in situ cleaning process for removal of the residue build-up, the cleaning process comprising, in any order:  
passing a perfluorocarbon gas  $C_xF_y$  with  $y > 6$  through the showerheads into the chamber for a first duration at first flow rate, chamber pressure and RF power settings;

passing the gas through the showerheads into the chamber for a second duration at second flow rate, chamber pressure and RF power settings; the second duration being shorter than the first duration; and the second chamber pressure and RF power settings being greater than the first chamber pressure and RF power settings; and

passing the gas through the showerheads into the chamber for a third duration at third flow rate, chamber pressure and RF power settings; the third flow rate and chamber pressure settings being substantially less than, and the third RF power setting being less than, the first flow rate, chamber pressure and RF power settings;

the gas passed at the second flow rate, chamber pressure and RF settings serving to remove residue build-up from sides of the showerheads not removed by the gas passed at the first flow rate, chamber pressure and RF settings.

Claim 56 (new). The method of Claim 55, wherein the perfluorocarbon gas is selected from the group consisting of: octafluoropropane ( $C_3F_8$ ), cyclic-octafluorobutane (c- $C_4F_8$ ), and octafluorotetrahydrofuran ( $C_4F_8O$ ).

Claim 57 (new). The method of Claim 56, wherein the third flow rate setting is about 60% of the first flow rate setting; and the third chamber pressure setting is less than 30% of the first chamber pressure setting.

Claim 58 (new). The method of Claim 57, wherein the second duration is about 25% of the first duration.

Claim 59 (new). The method of Claim 58, wherein the second flow rate setting is substantially equal to the first flow rate setting.

Claim 60 (new). The method of Claim 56, wherein the first and third pressure settings are between about 3.0 and 4.0 Torr; the second pressure setting is between about

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0.5 and 0.8 Torr; the first and third flow rate settings are substantially the same between about 600 and 1200 sccm; and the second flow rate setting is about 500 sccm.

Claim 61 (new).        The method of Claim 60, wherein the first, second and third RF power settings are between about 2000 and 4000 Watts.

Claim 62 (new).        The improvement of Claim 60, wherein oxygen is passed together with the perfluorocarbon gas, with a ratio of flow rate of oxygen to flow rate of fluorocarbon gas for each of the first, second and third flow rate settings being between about 2:1 and 4:1.

Claim 63 (new).        The improvement of Claim 62, wherein oxygen is passed at a flow rate setting between about 1900 and about 3000 sccm for the first and third durations, and at a flow rate setting between about 1000 to 2000 sccm during the second duration.

Claim 64 (new).        The in situ cleaning process of Claim 55, wherein moving from one cleaning step to another is done in response to measuring fluorine and carbon monoxide by-products using an optical spectrometer configured to measure optical emission signals at 704 and 483 nanometers, respectively.